Course: Relational systems

Course instructors: Miroslav D. Ćirić, Stefan P. Stanimirović

Course type: Elective

Credit points ECTS: 12

Prerequisites: No

Course objectives:

Acquiring advanced knowledge of classical Boolean relations, relational systems and relation algebras, their generaliza-tions and basic applications.

Learning outcomes:

Upon completion of the course, the student should master advanced knowledge of classical Boolean relations, relational systems and relation algebras, their generalizations - fuzzy and weighted relations and relational systems, as well as their applications in the theory of transition systems and automata, network analysis, concept analysis, modal logic and other areas.

Course description (outline):

Algebra of relations: set operations, conversion, composition, residuals, properties of relations; relations and Boolean matrices; relation algebras: definition and axiomatization, properties of relation algebras. Generalizations of relation alge-bras: residuated lattices and quantales.

Generalizations of classical Boolean relations and Boolean relational systems: fuzzy relations and fuzzy relational systems, fuzzy equivalences and fuzzy quasi-orders, quotient fuzzy relational systems, uniform fuzzy relations; weighted relations and weighted relational systems; matrices over semirings, Boolean and fuzzy matrices; semimodules and bisemimodules of relations; solving systems of relational equations and inequations with Boolean, fuzzy and weighted relations.

Applications of relational systems: transition systems and automata, quantitative automata - fuzzy automata, weighted auto-mata; network analysis - social networks, traffic, transport, and production networks, other types of networks; concept ana-lysis; relational systems and modal logics, Kripke models; approximation operators and rough sets; relational databases.

References:

23. G. Schmidt, Relational Mathematics (Encyclopedia of Mathematics and its Applications), Cambridge University Press, Cambridge, 2010.
24. S. Givant, Introduction to Relation Algebras, Springer International Publishing, 2017.
25. R. Sz. Madarász, S. Crvenković, Relation Algebras (in Serbian), Matematički Institut SANU, Beograd, 1992.
26. R. Belohlávek, Fuzzy Relational Systems: Foundations and Principles, Kluwer Academic Publishers, New York, 2002.
27. J. Ignjatović, M. Ćirić, Automata and formal languages (in Serbian), Univerzitet u Nišu, Prirodno-matematički fakultet, Niš, 2016.
28. U. Brandes, T. Erlebach (Eds.), Network Analysis: Methodological Foundations, Lecture Notes in Computer Science, vol. 3418, Springer, 2005.

Active teaching hours: 5	Theoretical classes: 5	Practice classes:

Methods of teaching:

The lectures use classical teaching methods with the use of modern information and communication technologies and interaction with students. Students' knowledge is tested through homework and defense of seminar papers. The final oral exam checks the comprehensive understanding of the presented material.

Grading structure (100 points)

Activity during the lectures: *10 points*; homework and seminars: *20 points*; oral exam: *70 points*.